HO_x and NO Observations during INTEX-A

X. Ren J. Mao R. Long R. Lesher W. Brune
Department of Meteorology
Pennsylvania State University

HO_x and NO measurement techniques

- **OH and HO_2 measurements**

ATHOS — Airborne Tropospheric Hydrogen Oxides Sensor

  – Laser-induced fluorescence (LIF) detection of OH

  – Chemically convert HO_2 to OH by HO_2+NO followed by the detection of OH with LIF

- **NO measurements**

TEI 42C NO-NO_x analyzer

  – Chemiluminescence
  – NO single mode
  – Online NO span and zero checks

Data Quality

- Data coverage:

  OH (1 min) - 97%

  HO_2 (1 min) - 95%

  NO (1 min) - 89%

- Typical uncertainties:

  HO_x ±32% (2σ)

  NO ±30% (2σ)

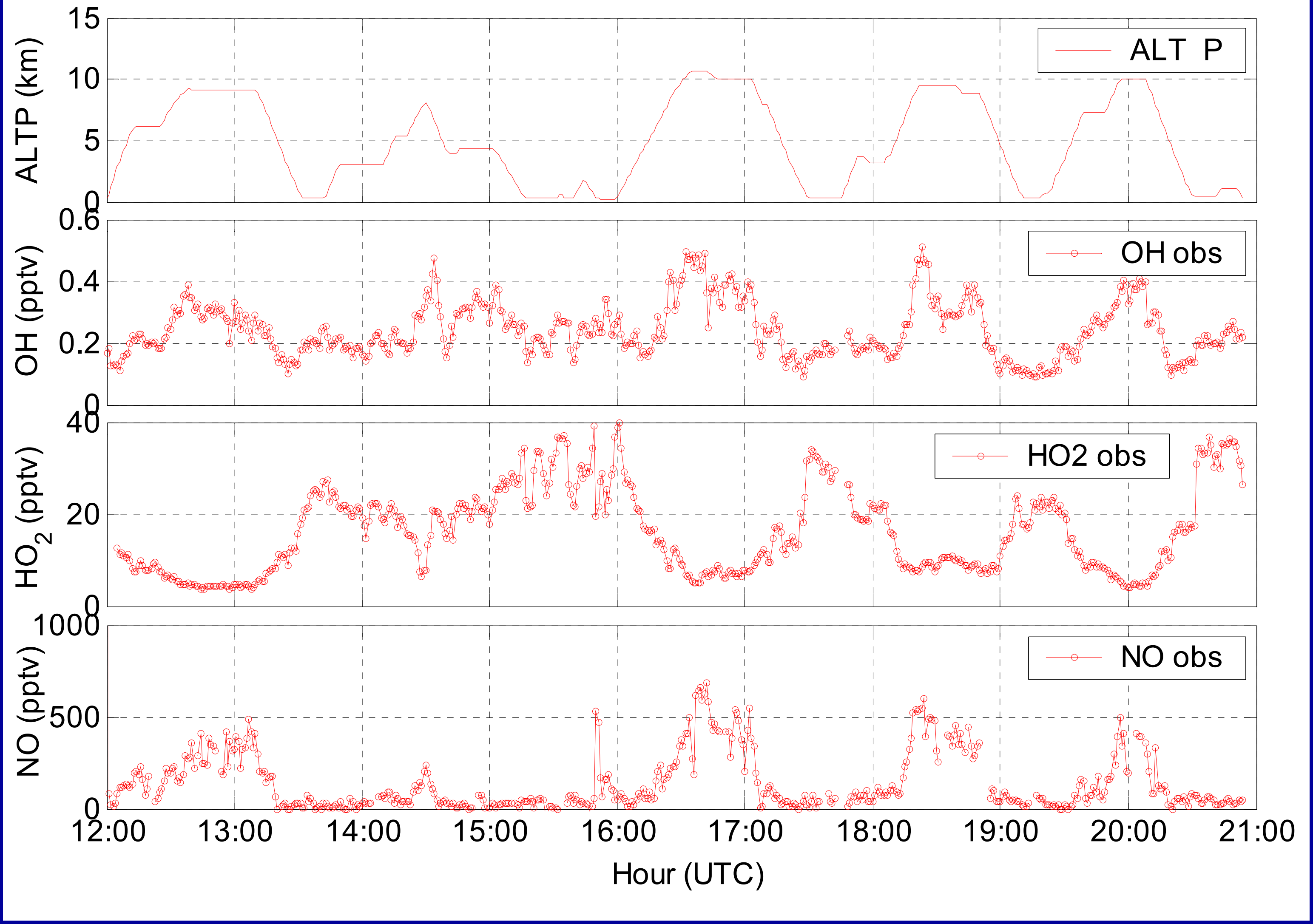
- Detection limits:

  OH 0.01 pptv

  HO_2 0.1 pptv

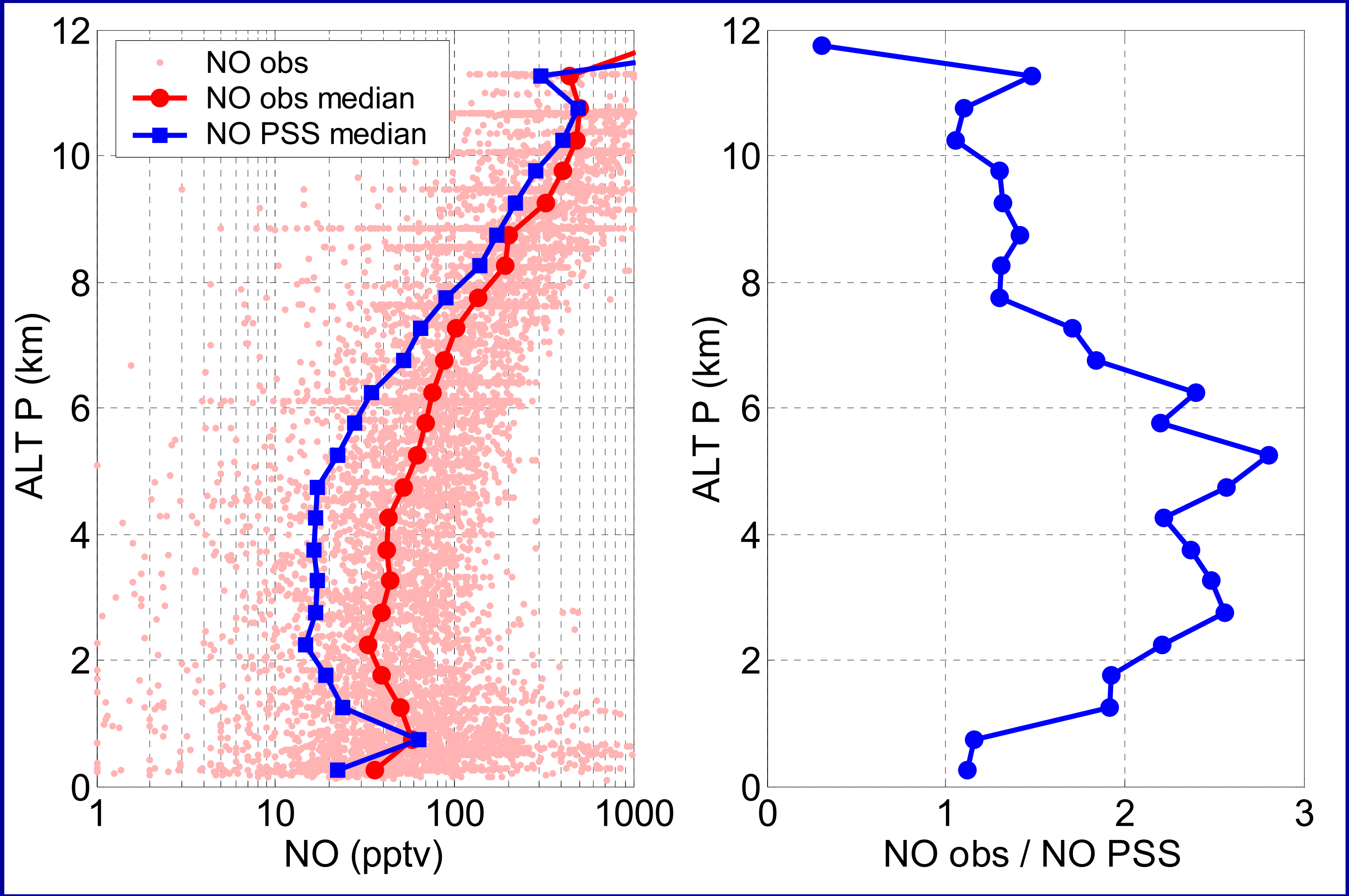
  NO 50 ppt

HO_x and NO observations (July 22, Flight 11)

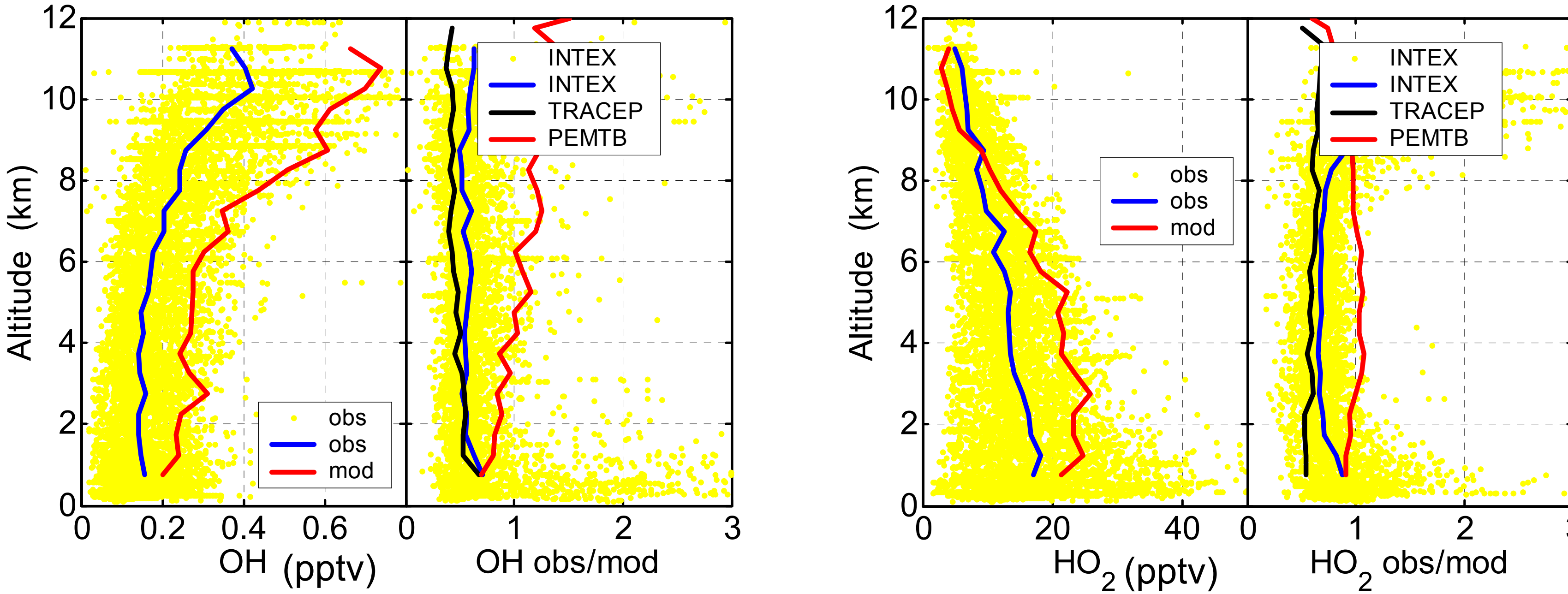


HO_2 and OH have good precision – sub-minute resolution will be used to examine variability.

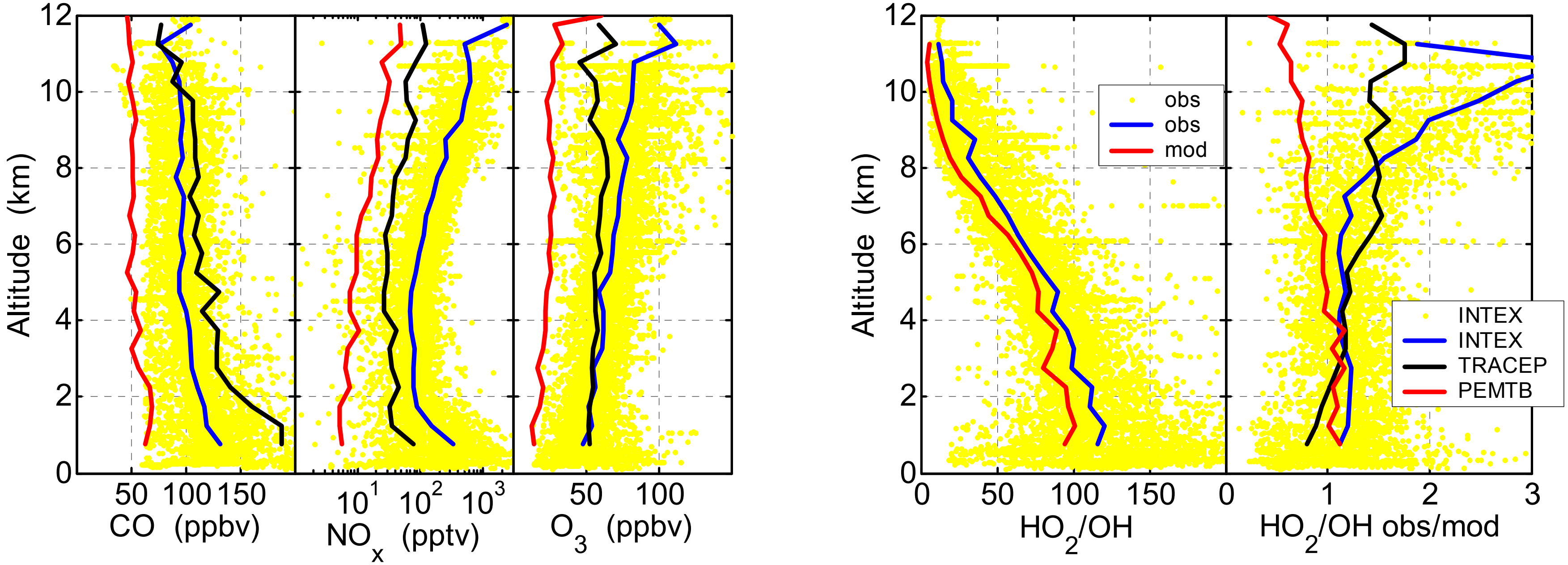
Observed & PSS NO vertical profiles



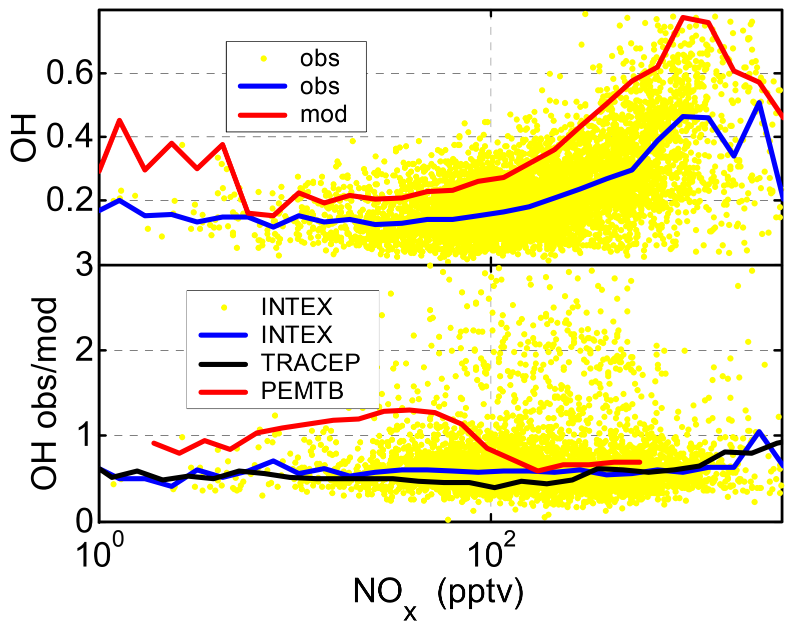
The NO values between 2-6 km are around or below the NO detection limit (~50 pptv).

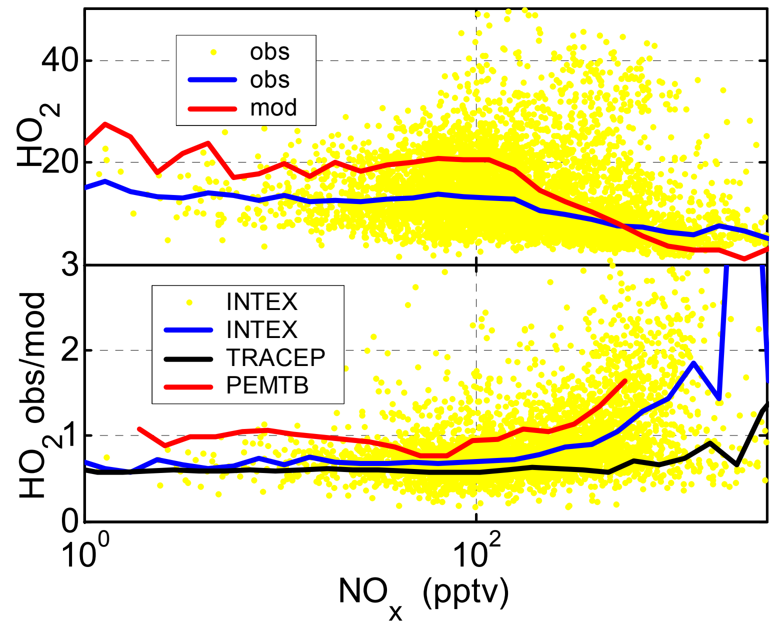


- Median observed-to-modeled OH ~ 0.6 at all altitudes.
- Median observed-to-modeled HO_2 ~ 0.8 up to 8 km.
- Behavior is similar to that in TRACE-P.
- Large observed-to-modeled OH in PBL correlates to isoprene (from Jim Crawford) as seen in forests.



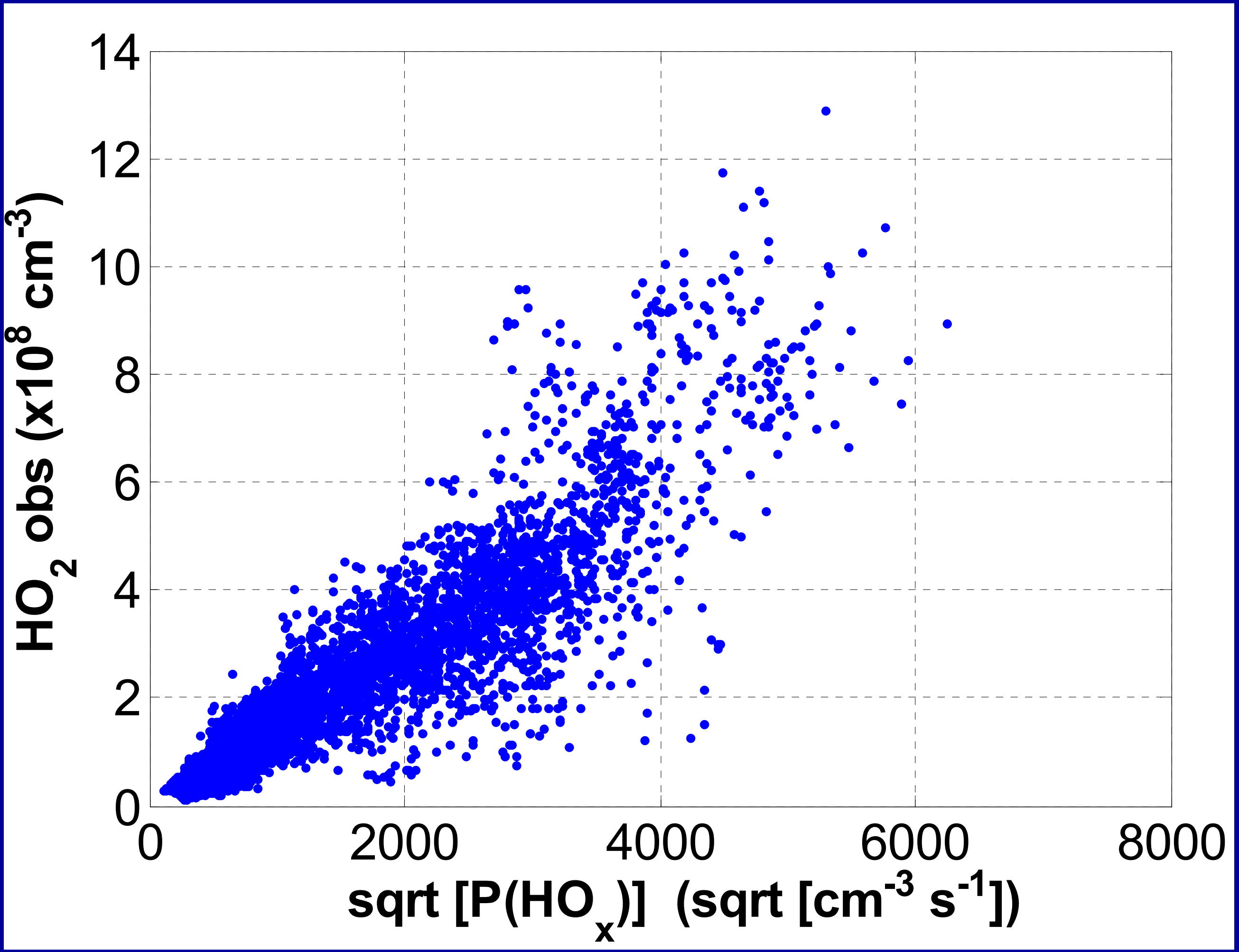
- NO_x in INTEX-A is greater than in TRACE-P & PEM TB; CO and O_3 are similar in INTEX-A & TRACE-P.
- Observed-to-modeled HO_2/OH is close to 1 below 7 km, but exceeds 2 above ~9 km.
- HO_2/OH deviations appear to be NO_x related.





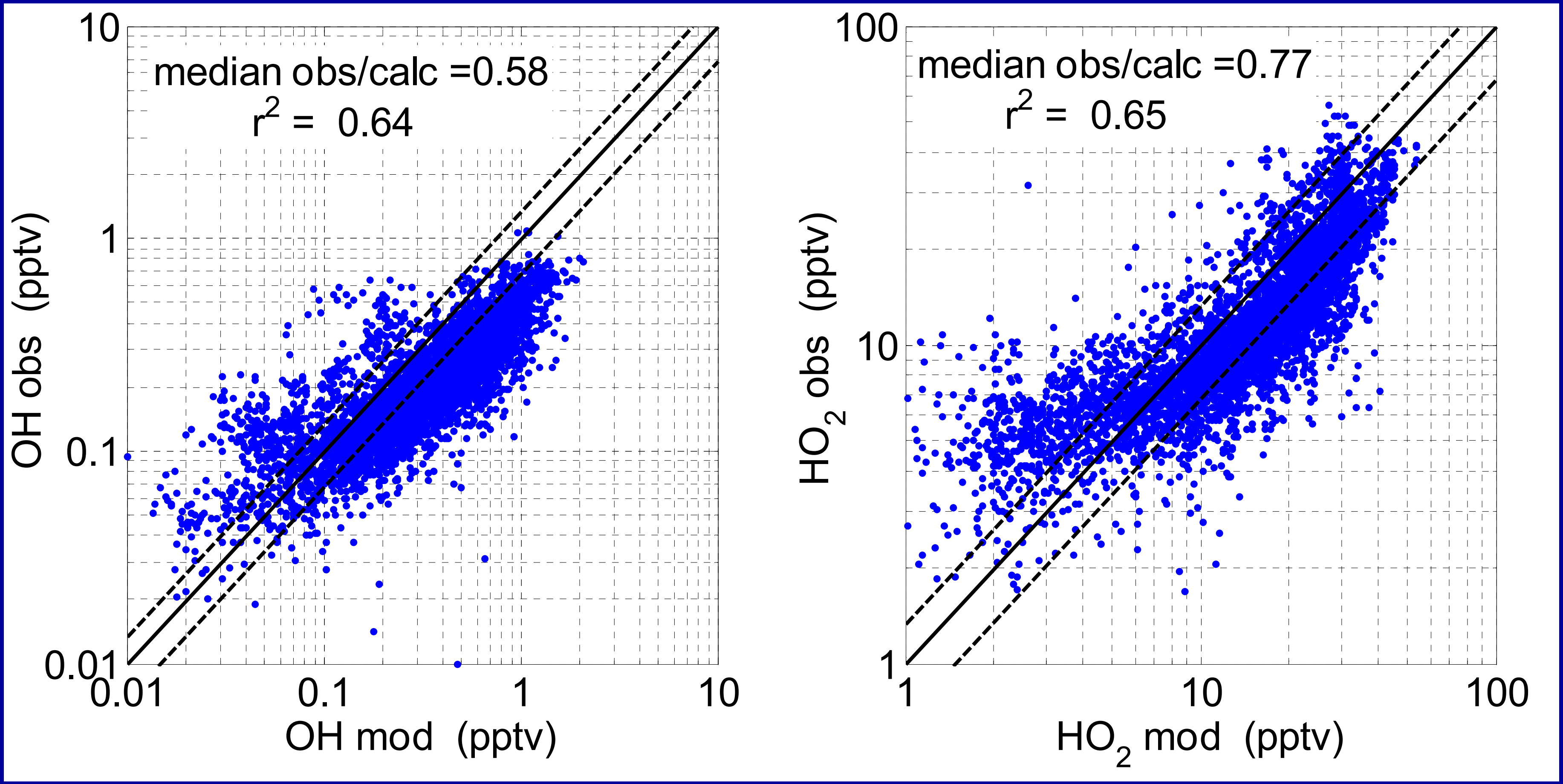
- Observed-to-modeled OH shows little NO_x-dependence.
- Observed-to-modeled HO_2 grows for NO_x > few 100 pptv.
- INTEX-A and TRACE-P dependences on NO_x are similar.
- Observed-to-modeled HO_2 < 1 for NO_x < few 100 pptv &
  > 1 for NO_x > few 100 pptv is usually observed by us
  and a few others.

HO_2 versus $(PHO_x)^{1/2}$



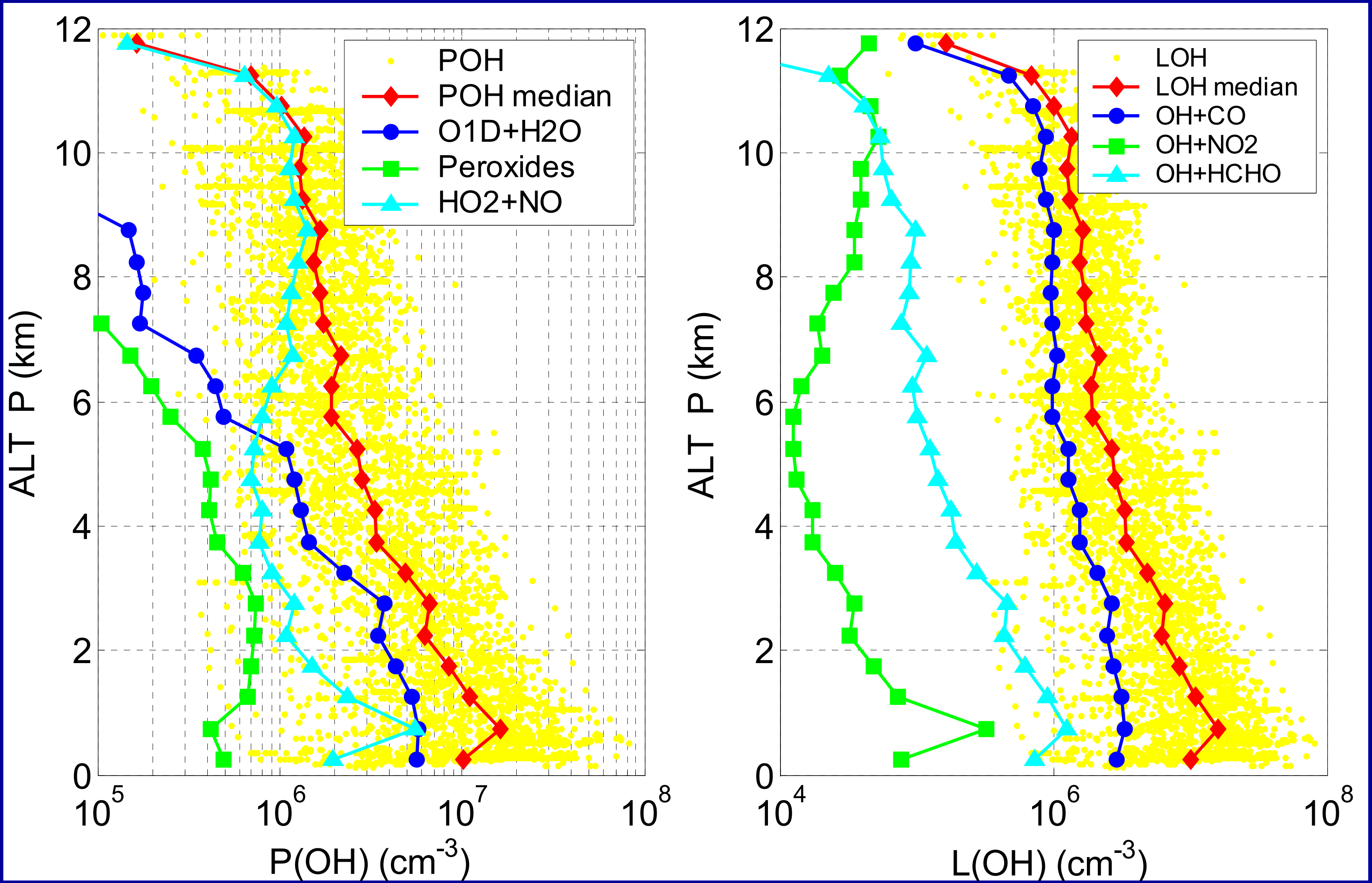
- $P(HO_x) = L(HO_x) \propto [\ HO_2\ ]^2$, so $[\ HO_2\ ] \propto \mathrm{sqrt}\ \{P(HOx)\}$.
- Much HO_2 variance can be explained by $P(HO_x)$.

HO_x observed & modeled comparisons



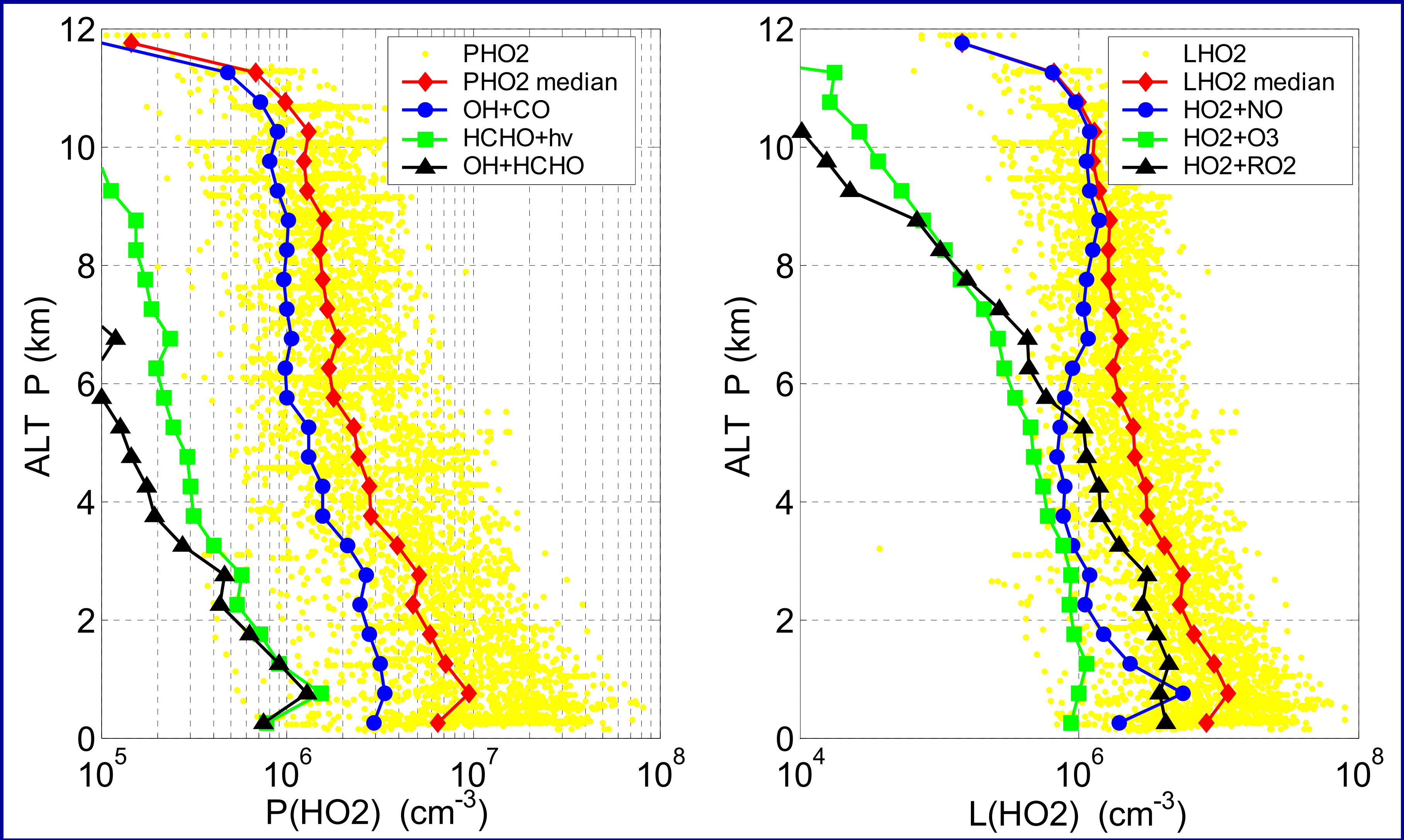
- Solid line: 1:1; dashed lines: obs. uncertainty ±32%.
- HO_x comparison similar to that in TRACE-P.

Modeled OH production and loss



Main P(OH) is O^1D+H_2O (below 5 km) and HO_2+NO (above 5 km).
Main L(OH) is OH+CO/VOC.

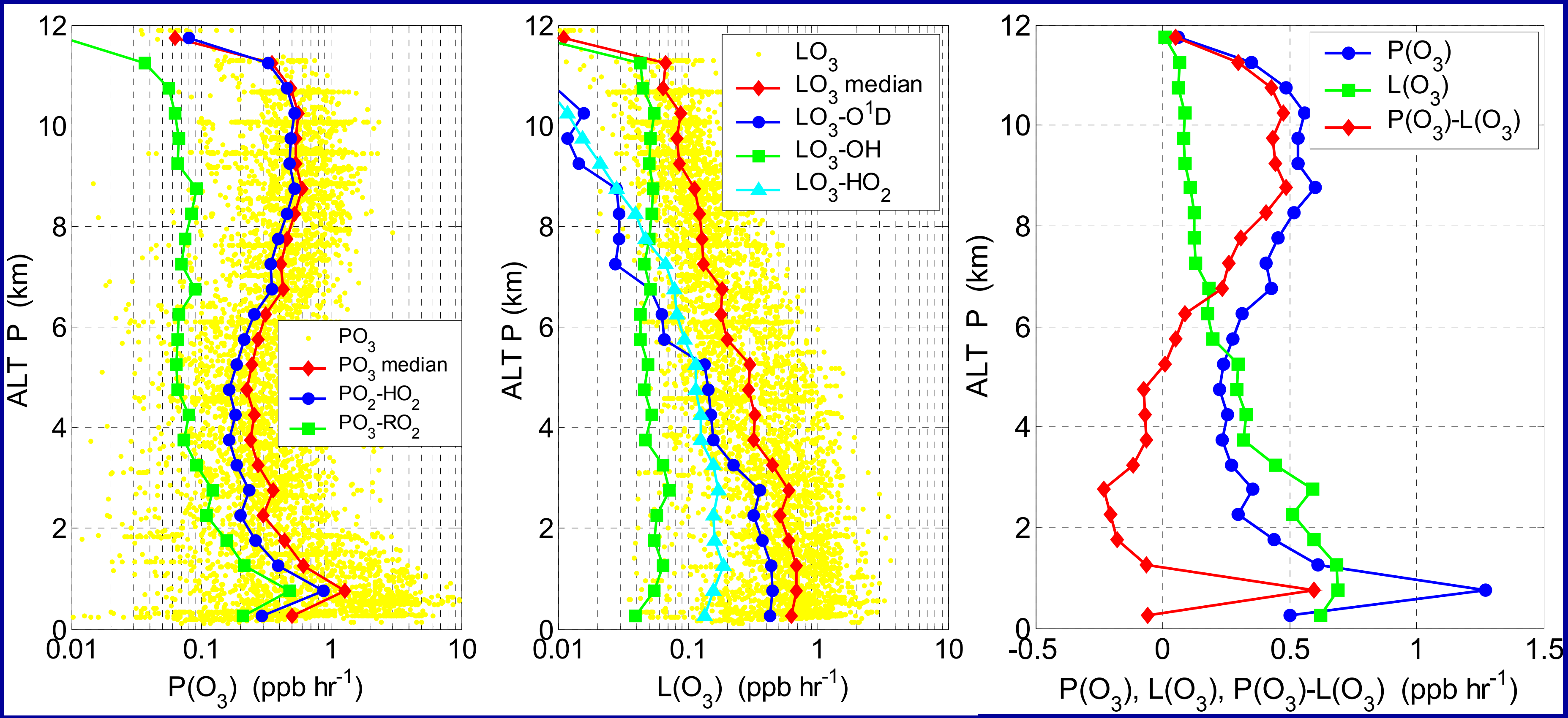
Modeled HO_2 production and loss



Main $P(HO_2)$ is OH+CO.

Main $L(HO_2)$ is HO_2-RO_2 self-reactions (below 5 km) & HO_2+NO (above 5 km).

O_3 budget



- Main P(O_3): HO_2+NO.
- Main L(O_3): O^1D+H_2O (< 5 km) & O_3+HO_2/OH (> 5 km).
- Net O_3 loss at altitudes between 1 km and 5 km.

Science questions we hope to answer

- General comparisons between observed and modeled HO_x
  - Were previous observed-to-modeled anomalies also observed in INTEX-A? (e.g., NO_x-dependence of observed-to-modeled HO_2)
  - Can the HO_x heterogeneous effects (or lack thereof) be understood?
- High speed photochemistry – one-to-a-few seconds
  - What are the effects of scale on calculating $P(O_3)$ from HO_2 & NO?
  - Is HO_x behavior understood in urban, forest-fire, and long-range regionally transported plumes?
- HO_x behavior in the planetary boundary layer
  - What is the behavior of HO_x and $P(O_3)$ and vertical distribution in the boundary layer?
  - Is isoprene chemistry in forested regions adequately understood?
- Collaborations with many others on these & other questions.